

What is claimed is:

1. A tire alarm device that gives a warning against a runflat operation limit of a pneumatic tire during runflat operation having a reinforcement layer disposed in each sidewall thereof for enabling the runflat operation, comprising a tire temperature sensor to be disposed on an inner surface of one of the sidewalls facing the reinforcement layer therein, the tire temperature sensor being used to warn of the runflat operation limit.
2. A tire alarm device that gives a warning against a runflat operation limit of a pneumatic tire supported during runflat operation by a runflat support member mounted on a rim of a wheel, comprising a tire temperature sensor to be disposed on a support region of the runflat support member that supports the pneumatic tire in contact therewith, the tire support sensor being used to warn of the runflat operation limit.
3. A tire alarm device that gives a warning against a runflat operation limit of a pneumatic tire supported during runflat operation by a metallic support element of a runflat support member mounted on a rim of a wheel, comprising a tire temperature sensor to be disposed on the metallic support element, the tire support sensor being used to warn of the runflat operation limit.
4. A tire alarm device according to claim 1, 2 or 3, comprising a processing means that determines whether or not the tire has reached a zone of the runflat operation limit based on a signal detected by the temperature sensor, and a warning means that

gives a warning if the processing means determines that the tire has reached the runflat operation limit zone.

5. A tire alarm device according to claim 4, comprising a tire side unit having the tire temperature sensor and a transmitting means that transmits the signal detected by the tire temperature sensor, and a vehicle side unit having a receiving means that receives the signal from the transmitting means, the processing means and the warning means.

6. A tire alarm device according to claim 5, wherein the vehicle side unit has a memory that stores a preset limit temperature data according to the runflat operation limit zone, and wherein the processing means compares a temperature data value of the signal detected by the tire temperature sensor with a value of the limit temperature data, and determines that the tire has reached the runflat operation limit zone if the temperature data value of the detected signal exceeds the limit temperature data value.

7. A tire alarm device according to claim 6, wherein the tire side unit has a tire inner pressure sensor for detecting pressure in a cavity of the pneumatic tire, and wherein the processing means determines whether or not a value of the pressure detected by the tire inner pressure sensor is below a prescribed threshold value, and determines that the tire is operated in a runflat condition if the detected pressure value is less than the prescribed threshold value, and determines whether or not the

tire has reached the runflat operation limit zone if the processing means determines that the tire is operated in the runflat condition.

8. A tire alarm device according to claim 7, wherein the memory stores time history data of the temperature detected, and wherein the processing means calculates a sectional approximate function of the temperature time history data by using at least four consecutive temperature data including a latest temperature data in the temperature time history data stored in the memory if the processing means determines that the tire has not reached the runflat operation limit zone, and estimates values of the temperature after the latest temperature data in time series by an extrapolation method using the sectional approximate function, and calculates a time interval reaching the limit temperature data value on the basis of the estimated temperature values.

9. A tire alarm device according to claim 1, 2 or 3, comprising a tire inner pressure sensor for detecting pressure in a cavity of the pneumatic tire, a speed obtaining means for obtaining a running speed of a vehicle on which the pneumatic tire is mounted, a processing means that determines whether or not the tire has reached a zone of the runflat operation limit based on signals from the tire temperature sensor, the tire inner pressure sensor and the speed obtaining means, and a warning means that gives a warning if the processing means determines that the tire has

reached the runflat operation limit zone.

10. A tire alarm device according to claim 9, wherein the processing means calculates a temporal integration value obtained by integrating by time a total evaluation function  $f_4$  that is a combination of an evaluation function  $f_1$  for evaluating degree of risk according to the tire inner pressure, an evaluation function  $f_2$  for evaluating degree of risk according to the vehicle running speed and an evaluation function  $f_3$  for evaluating degree of risk according to the tire temperature and has variables according to time, and determines whether or not the tire has reached the runflat operation limit zone based on the temporal integration value and a preset limit value  $L$ .

11. A tire alarm device according to claim 10, comprising a memory storing the preset limit value  $L$ , the processing means comparing the temporal integration value with the preset limit value  $L$  and determining that the tire has reached the runflat operation limit zone if the temporal integration value exceeds the preset limit value  $L$ .

12. A tire alarm device according to claim 11, wherein the processing means determines whether or not a value of the pressure detected by the tire inner pressure sensor is below a prescribed threshold value, and determines that the tire is operated in a runflat condition if the detected pressure value is less than the prescribed threshold value, and determines whether or not the tire has reached the runflat operation limit zone if the

processing means determines that the tire is operated in the runflat condition.

13. A tire alarm device according to claim 12, wherein the memory stores values of the total evaluation function  $f_4$  as time history data, and wherein, if the processing means determines that the tire has not reached the runflat operation limit zone, the processing means calculates a sectional approximate function  $f'_4$  of the total evaluation function  $f_4$  by using at least four consecutive data including a latest data in the time history data of the values of the total evaluation function  $f_4$  stored in the memory, and estimates values of the total evaluation function  $f_4$  after the latest data in time series by an extrapolation method using the sectional approximate function  $f'_4$ , and calculates a time interval until the tire reaches the runflat operation limit zone, using the values estimated in time series and the limit value  $L$ .

14. A tire alarm device according to claim 9, 10, 11, 12 or 13, comprising a tire side unit having the tire temperature sensor, the tire inner pressure sensor and a transmitting means that transmits the signals detected by the tire temperature sensor and the tire inner pressure sensor, and a vehicle side unit having a receiving means that receives the signals from the transmitting means, the processing means and the warning means.